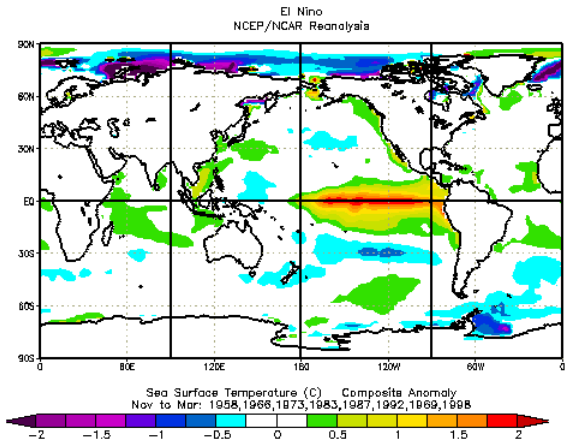
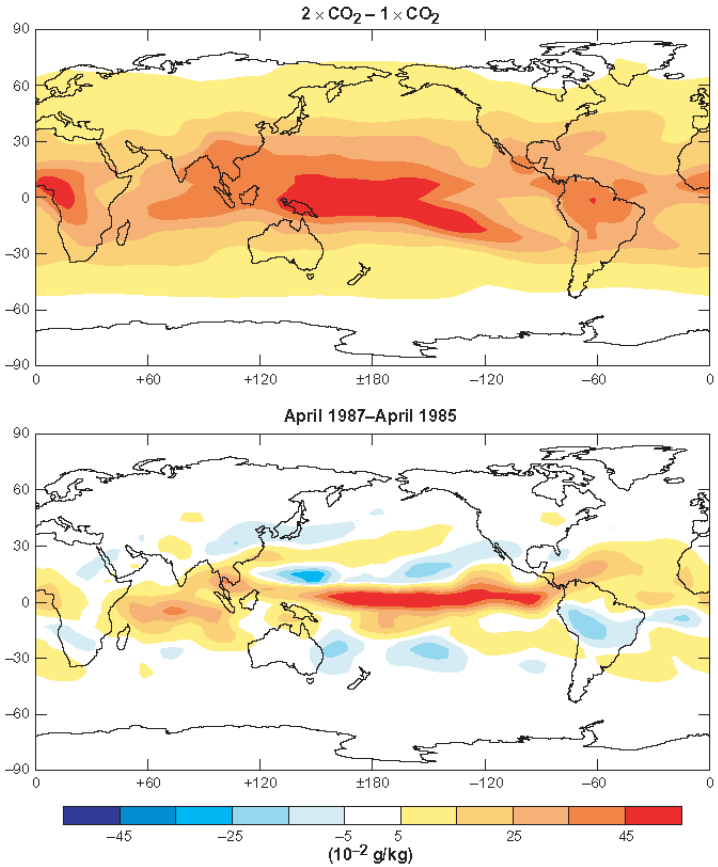
Why Can't GCMs Simulate ENSO?



Tony Del Genio, NASA/GISS

ENSO is not a good direct proxy for climate change…but it is a good observable test of GCM physics…

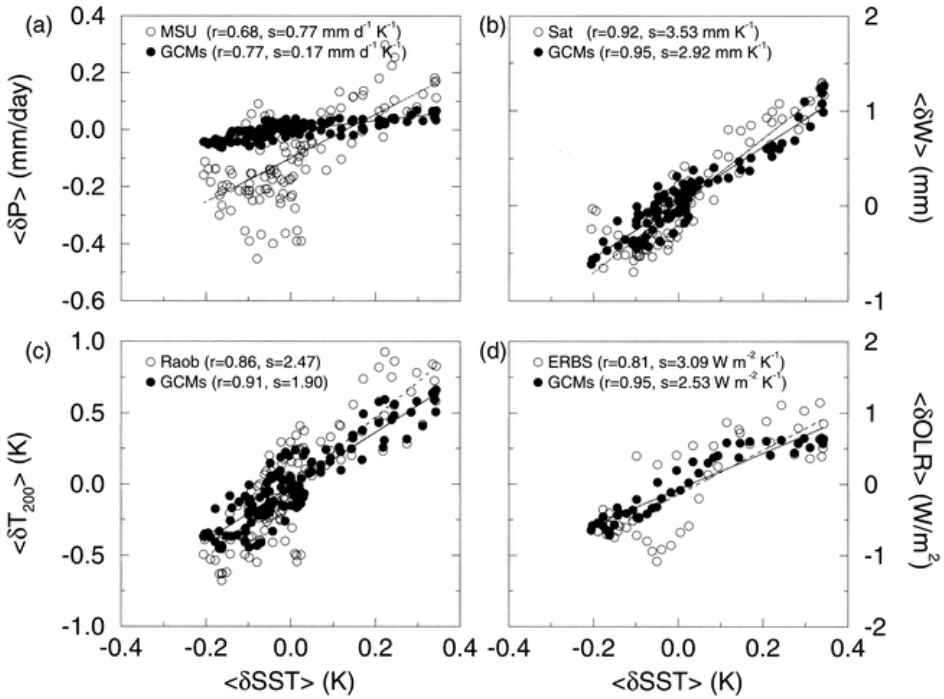


Doubled CO_2 vs. ENSO UTH Anomalies

(Del Genio, 2002)

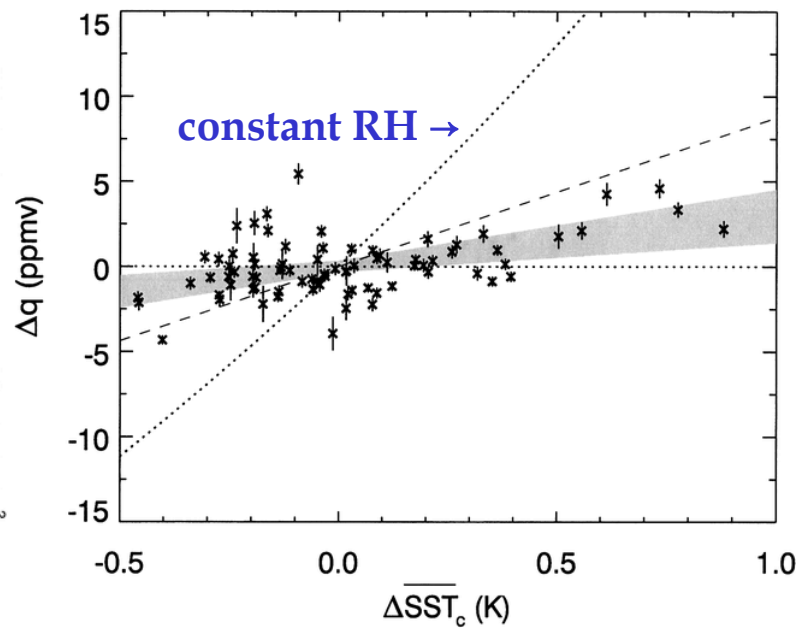
…and GCMs do not pass the test with flying colors

AMIP vs. observed composite ENSO anomalies



Soden (2000)

HALOE 215 mb q anomalies



Minschwaner and Dessler (2004)

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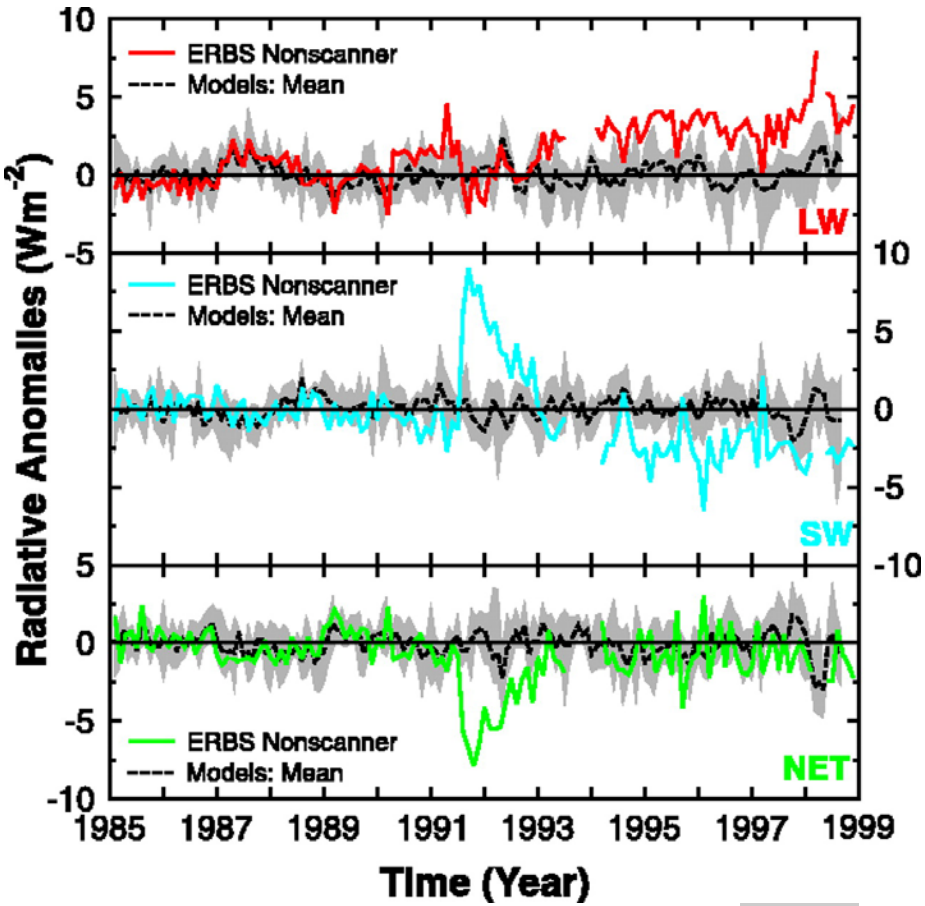
CSU, 8/4/04

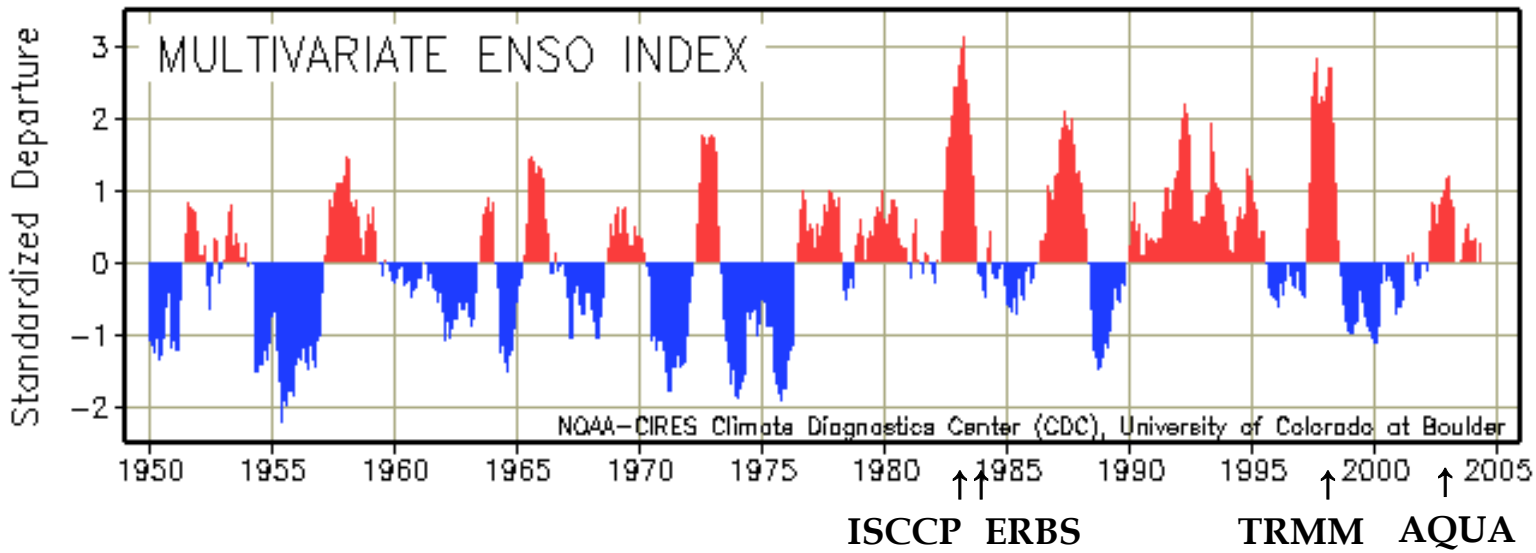
Goddard Institute for Space Studies

GCM variability appears to be sluggish on decadal time scales as well



Wielicki et al. (2002)

Murphy's Law, Corollary #6257: NASA always launches 6 months too late



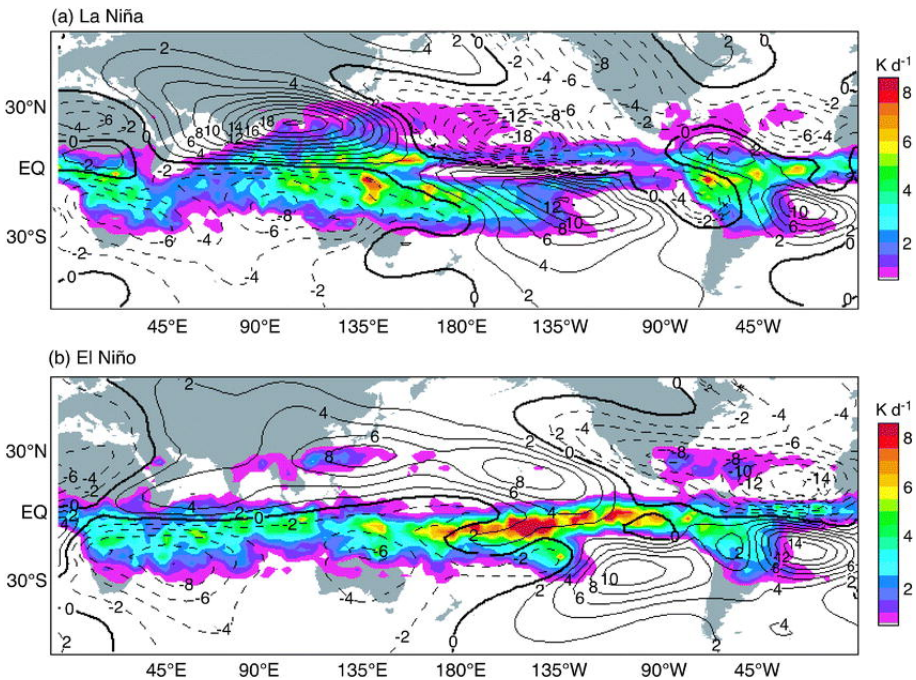
Strategy: Focus on 2002-3 (moderate) and 1997-8 (strong) ENSOs using AMSR-E, TRMM and their overlap as constraints for GCM simulations at several resolutions

Possible sources of GCM errors

- **Precipitation anomalies (AMSR-E, TRMM)**
- **Latent heating profile anomalies (AMSR-E, TRMM)**
- **Radiative heating profile anomalies (TRMM, MODIS)**
- **Clear-sky water vapor problems (AMSR-E, AIRS)**
- **Marine stratocumulus anomalies (AMSR-E, MODIS)**
- **Circulation response to heating (ERA-40)**

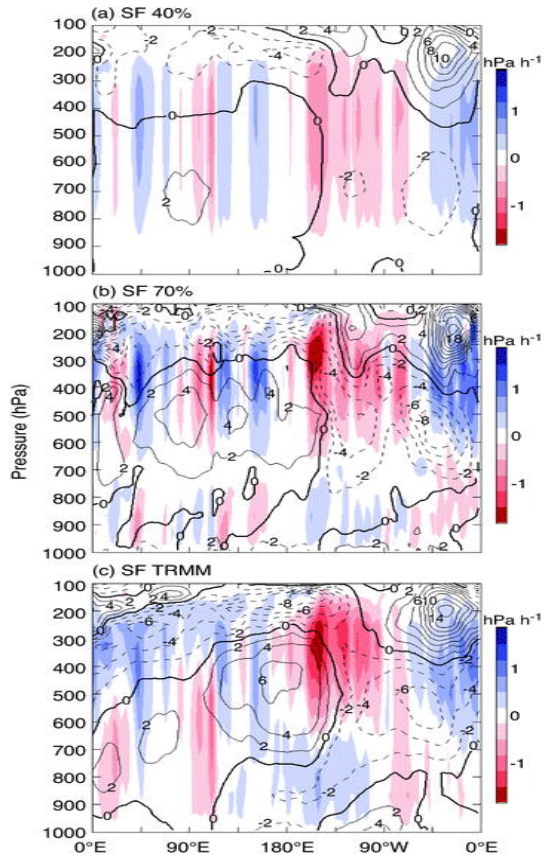
ENSO variation in Walker cell strength is sensitive to vertical heating profile

400 mb latent heating

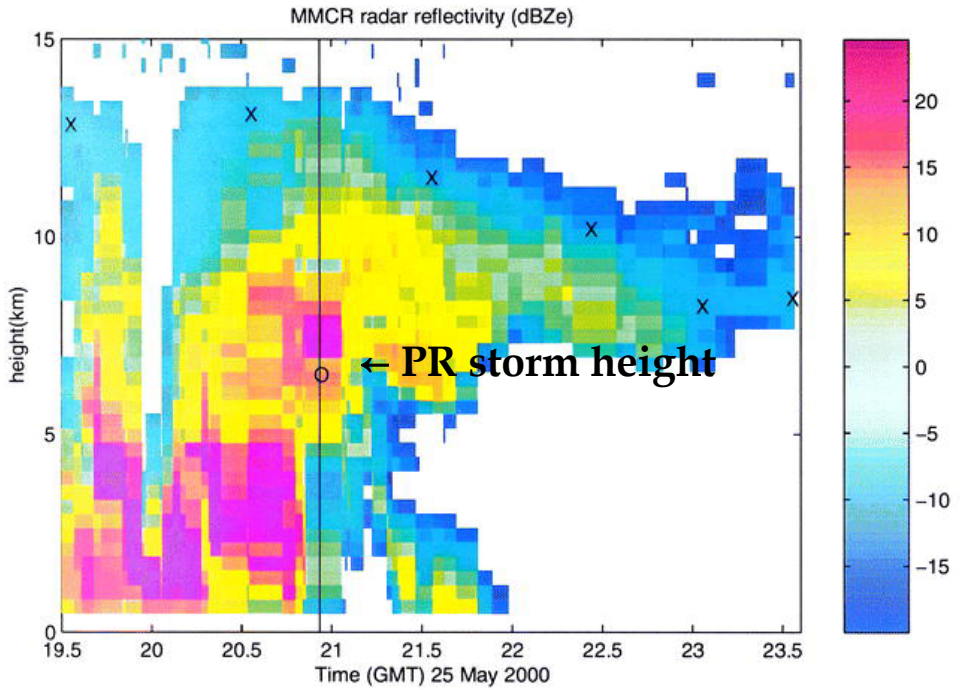


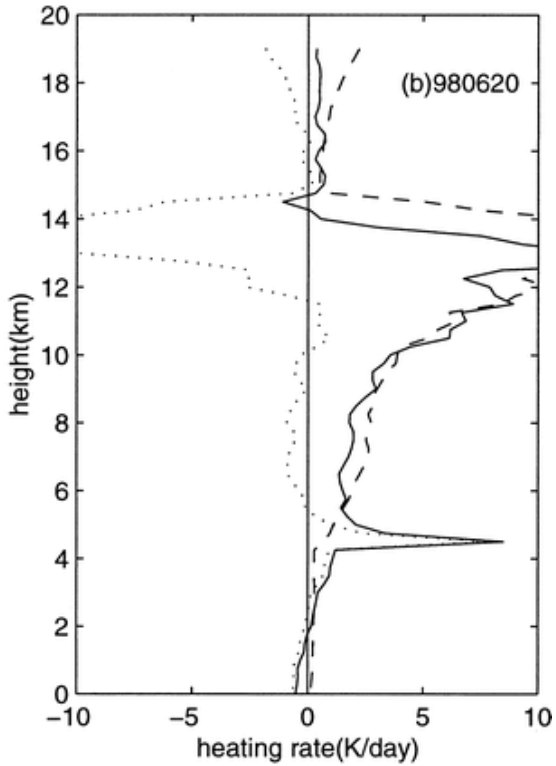
Schumacher et al. (2004)

Stratiform rain fraction influence on vertical velocity



Anvil diabatic heating is non-negligible; has different profile from latent heating



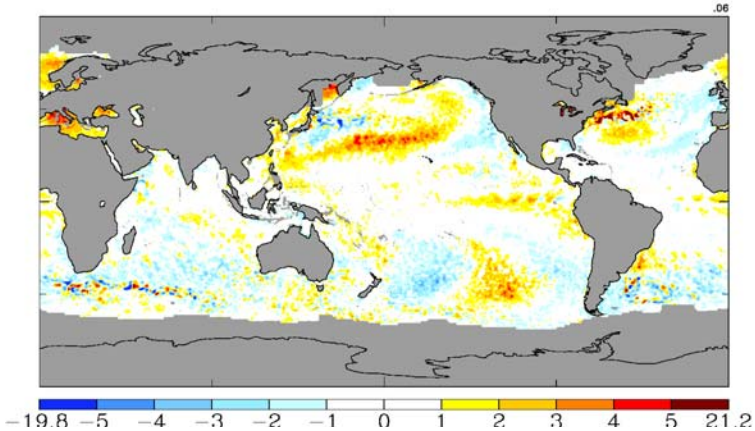


Jensen and Del Genio (2003)

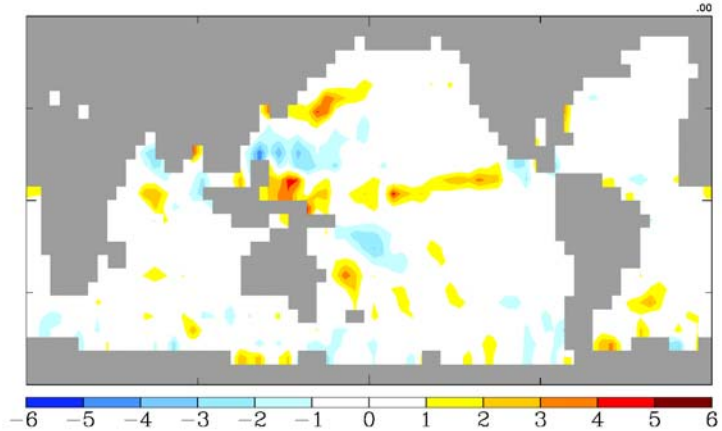
Identifying errors using AMSR-E gridded monthly mean ENSO anomalies

(OK, June 2004 is not ideal but it's the best you've processed so far)

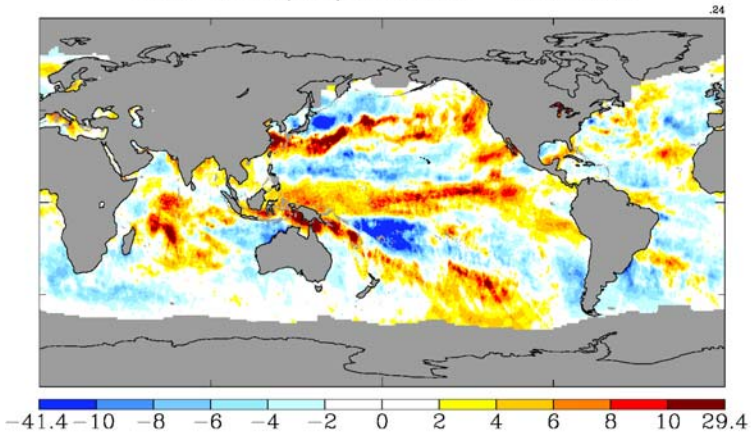
SST(C) JUNE 2002 – JUNE 2004



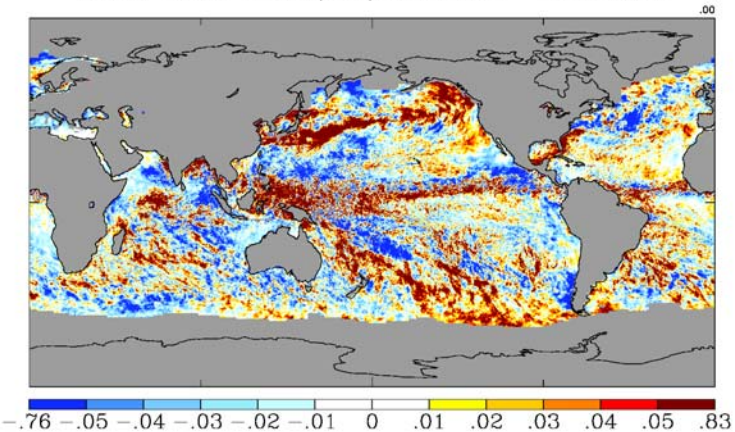
PRECIPITATION (mm) JUNE 2002 – JUNE 2004



WATER VAPOR(mm) JUNE 2002 – JUNE 2004



CLOUD LIQUID WATER(mm) JUNE 2002 – JUNE 2004



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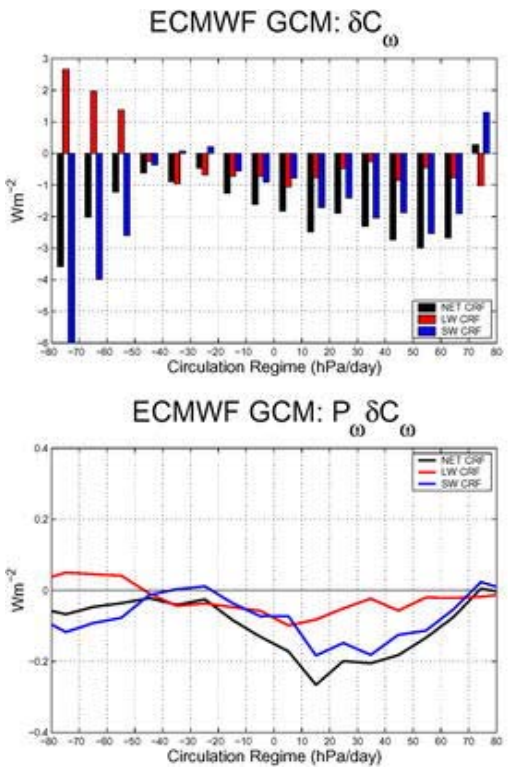
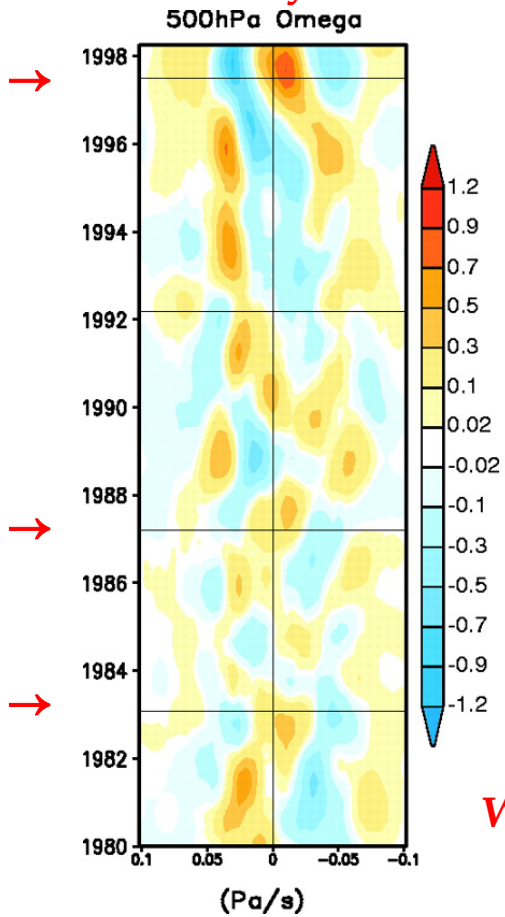
From identifying errors to fixing them: 1. Parameter dependences

Regime-weighted climate change



Bony et al. (2004)

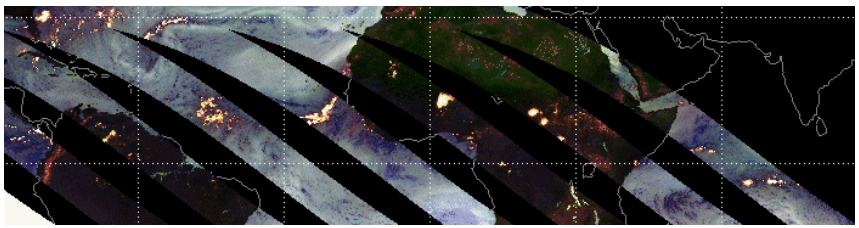
Vertical velocity Hovmöller

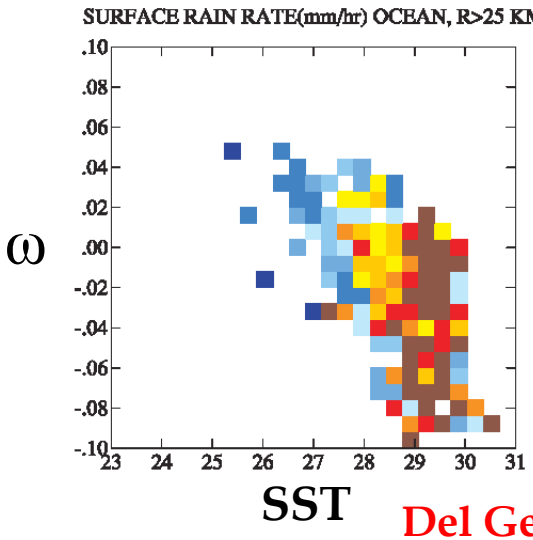


Wielicki et al. (2002)

From identifying errors to fixing them: 2. Cloud object statistics and composites

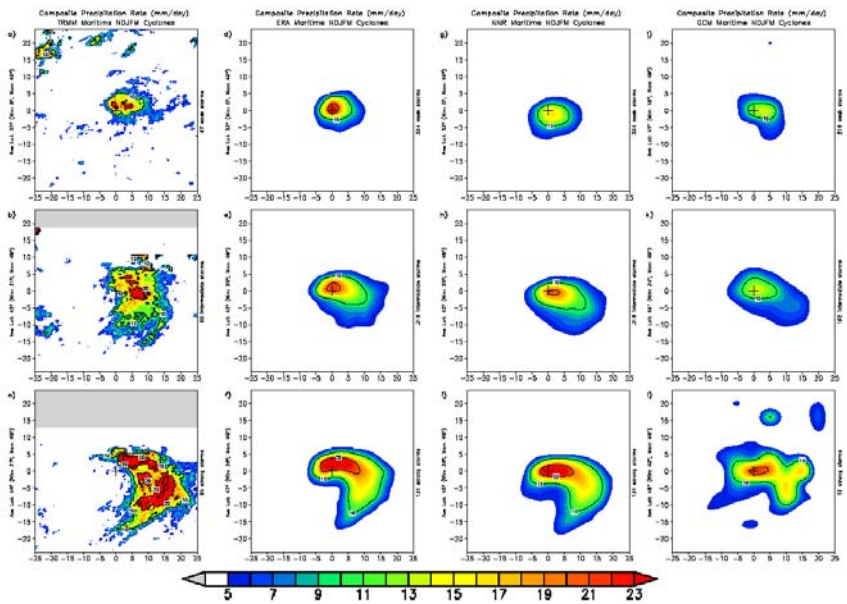
TRMM convective storm statistics





Del Genio and Kovari (2002)

TRMM vs. model composite midlatitude storms



Bauer and Del Genio (2004)